

This form is a summary description of the model entitled “FlexibleBarrier” proposed for the Model Checking Contest @ Petri Nets. Models can be given in several instances parameterized by scaling parameters. Colored nets can be accompanied by one or many equivalent, unfolded P/T nets. Models are given together with property files (possibly, one per model instance) giving a set of properties to be checked on the model.

Description

This model describes a barrier algorithm that synchronizes several concurrent processes. The number of concurrent processes evolves dynamically over time. Between two successive synchronizations, processes can be killed or can fork new processes: all live processes have to be synchronized by the barrier. This algorithm is used in cooperative kernels, a novel technique that allows safe multitasking for irregular data-parallel algorithms on GPUs.

This collection of P/T nets was derived from an LNT model of the Flexible Barrier. Each instance was first translated to LOTOS, and then to an interpreted Petri net using the [CADP](#) toolbox. Finally, a P/T net was obtained by stripping out all data-related information (variables, types, assignments, guards, etc.) from the interpreted Petri net, leading to a NUPN (Nested-Unit Petri Net) model translated to PNML using the [CÆSAR.BDD](#) tool.

Each instance of the model is parameterized by the maximal number N of concurrent processes that synchronize on the barrier. Each instance is also parameterized by its version V , which specifies how the NUPN has been produced from the LOTOS specification. V is either equal to “ a ” if the NUPN has been generated *after* applying all the structural and data-flow optimizations of the [CÆSAR](#) compiler for LOTOS, or to “ b ” if the NUPN has been generated *before* these optimizations.

References

Scaling parameter

| Parameter name | Parameter description | Chosen parameter values |
|----------------|--|---|
| (N, V) | N is the maximal number of concurrent processes and V is the version defined above | $\{4, 6, 8, 10, 12, 14, 16, 18, 20, 22\} \times \{a, b\}$ |

Size of the model

| Parameter | Number of places | Number of transitions | Number of arcs | Number of units | HWB code |
|-----------------|------------------|-----------------------|----------------|-----------------|-----------|
| $N = 04, V = a$ | 51 | 88 | 309 | 7 | 2-6-19 |
| $N = 04, V = b$ | 268 | 305 | 743 | 11 | 5-6-39 |
| $N = 06, V = a$ | 75 | 154 | 599 | 9 | 2-8-27 |
| $N = 06, V = b$ | 542 | 621 | 1533 | 15 | 7-8-60 |
| $N = 08, V = a$ | 99 | 236 | 985 | 11 | 2-10-35 |
| $N = 08, V = b$ | 920 | 1057 | 2627 | 19 | 9-10-76 |
| $N = 10, V = a$ | 123 | 334 | 1467 | 13 | 2-12-43 |
| $N = 10, V = b$ | 1402 | 1613 | 4025 | 23 | 11-12-94 |
| $N = 12, V = a$ | 147 | 448 | 2045 | 15 | 2-14-51 |
| $N = 12, V = b$ | 1988 | 2289 | 5727 | 27 | 13-14-111 |
| $N = 14, V = a$ | 171 | 578 | 2719 | 17 | 2-16-59 |
| $N = 14, V = b$ | 2678 | 3085 | 7733 | 31 | 15-16-140 |
| $N = 16, V = a$ | 195 | 724 | 3489 | 19 | 2-18-67 |
| $N = 16, V = b$ | 3472 | 4001 | 10043 | 35 | 17-18-159 |
| $N = 18, V = a$ | 219 | 886 | 4355 | 21 | 2-20-75 |
| $N = 18, V = b$ | 4370 | 5037 | 12657 | 39 | 19-20-177 |
| $N = 20, V = a$ | 243 | 1064 | 5317 | 23 | 2-22-83 |
| $N = 20, V = b$ | 5372 | 6193 | 15575 | 43 | 21-22-195 |
| $N = 22, V = a$ | 267 | 1258 | 6375 | 25 | 2-24-91 |
| $N = 22, V = b$ | 6478 | 7469 | 18797 | 47 | 23-24-214 |

Structural properties

| | |
|--|-------|
| ordinary — all arcs have multiplicity one | ✓ |
| simple free choice — all transitions sharing a common input place have no other input place | ✗ (a) |
| extended free choice — all transitions sharing a common input place have the same input places | ✗ (b) |
| state machine — every transition has exactly one input place and exactly one output place | ✗ (c) |
| marked graph — every place has exactly one input transition and exactly one output transition | ✗ (d) |
| connected — there is an undirected path between every two nodes (places or transitions) | ✓ (e) |
| strongly connected — there is a directed path between every two nodes (places or transitions) | ✗ (f) |
| source place(s) — one or more places have no input transitions | ✓ (g) |
| sink place(s) — one or more places have no output transitions | ✗ (h) |
| source transition(s) — one or more transitions have no input places | ✗ (i) |
| sink transitions(s) — one or more transitions have no output places | ✗ (j) |
| loop-free — no transition has an input place that is also an output place | ? (k) |
| conservative — for each transition, the number of input arcs equals the number of output arcs | ✗ (l) |
| subconservative — for each transition, the number of input arcs equals or exceeds the number of output arcs | ✗ (m) |
| nested units — places are structured into hierarchically nested sequential units ⁽ⁿ⁾ | ✓ |

(a) stated by [CÆSAR.BDD](#) version 2.7 on all 20 instances (10 values of $N \times 2$ values of V).

(b) stated by [CÆSAR.BDD](#) version 2.7 on all 20 instances (10 values of $N \times 2$ values of V).

(c) stated by [CÆSAR.BDD](#) version 2.7 on all 20 instances (10 values of $N \times 2$ values of V).

(d) stated by [CÆSAR.BDD](#) version 2.7 on all 20 instances (10 values of $N \times 2$ values of V).

(e) stated by [CÆSAR.BDD](#) version 2.7 on all 20 instances (10 values of $N \times 2$ values of V).

(f) from place 1 one cannot reach place 0.

(g) place 0 is a source place.

(h) stated by [CÆSAR.BDD](#) version 2.7 on all 20 instances (10 values of $N \times 2$ values of V).

(i) stated by [CÆSAR.BDD](#) version 2.7 on all 20 instances (10 values of $N \times 2$ values of V).

(j) stated by [CÆSAR.BDD](#) version 2.7 on all 20 instances (10 values of $N \times 2$ values of V).

(k) stated by [CÆSAR.BDD](#) version 2.7 to be true on 10 instance(s) out of 20, and false on the remaining 10 instance(s).

(l) stated by [CÆSAR.BDD](#) version 2.7 on all 20 instances (10 values of $N \times 2$ values of V).

(m) stated by [CÆSAR.BDD](#) version 2.7 on all 20 instances (10 values of $N \times 2$ values of V).

(n) the definition of Nested-Unit Petri Nets (NUPN) is available from <http://mcc.lip6.fr/nupn.php>

Behavioural properties

- safe** — *in every reachable marking, there is no more than one token on a place* ✓ ^(o)
dead place(s) — *one or more places have no token in any reachable marking* ? ^(p)
dead transition(s) — *one or more transitions cannot fire from any reachable marking* ? ^(q)
deadlock — *there exists a reachable marking from which no transition can be fired* ? ^(r)
reversible — *from every reachable marking, there is a transition path going back to the initial marking* ?
live — *for every transition t , from every reachable marking, one can reach a marking in which t can fire* ?

Size of the marking graphs

| Parameter | Number of reach-able markings | Number of tran-sition firings | Max. number of tokens per place | Max. number of tokens per marking |
|-----------------|------------------------------------|-------------------------------|---------------------------------|-----------------------------------|
| $N = 04, V = a$ | 20737 ^(s) | ? | 1 | 6 |
| $N = 04, V = b$ | $\geq 3.66789e+08$ ^(t) | ? | 1 ^(u) | 6 |
| $N = 06, V = a$ | $2.98598e+06$ ^(v) | ? | 1 | 8 |
| $N = 06, V = b$ | $\geq 4.63158e+10$ ^(w) | ? | 1 ^(x) | 8 |
| $N = 08, V = a$ | $4.29982e+08$ ^(y) | ? | 1 | 10 |
| $N = 08, V = b$ | $\geq 2.87705e+13$ ^(z) | ? | 1 ^(aa) | 10 |
| $N = 10, V = a$ | $6.19174e+10$ ^(ab) | ? | 1 | 12 |
| $N = 10, V = b$ | $\geq 1.14075e+17$ ^(ac) | ? | 1 ^(ad) | 12 |
| $N = 12, V = a$ | $8.9161e+12$ ^(ae) | ? | 1 | 14 |
| $N = 12, V = b$ | $\geq 6.12466e+20$ ^(af) | ? | 1 ^(ag) | 14 |
| $N = 14, V = a$ | $1.28392e+15$ ^(ah) | ? | 1 | 16 |
| $N = 14, V = b$ | $\geq 3.04107e+15$ ^(ai) | ? | 1 ^(aj) | 16 |
| $N = 16, V = a$ | $1.84884e+17$ ^(ak) | ? | 1 | 18 |
| $N = 16, V = b$ | $\geq 2.19392e+17$ ^(al) | ? | 1 ^(am) | 18 |
| $N = 18, V = a$ | $2.66233e+19$ ^(an) | ? | 1 | 20 |
| $N = 18, V = b$ | $\geq 1.51447e+19$ ^(ao) | ? | 1 ^(ap) | 20 |
| $N = 20, V = a$ | $3.83376e+21$ ^(aq) | ? | 1 | 22 |
| $N = 20, V = b$ | $\geq 1.00937e+21$ ^(ar) | ? | 1 ^(as) | 22 |
| $N = 22, V = a$ | $5.52061e+23$ ^(at) | ? | 1 | 24 |
| $N = 22, V = b$ | $\geq 6.53756e+22$ ^(au) | ? | 1 ^(av) | 24 |

- ^(o) safe by construction – stated by the CÆSAR compiler.
^(p) stated by CÆSAR.BDD version 3.3 to be false on 11 instance(s) out of 20, and unknown on the remaining 9 instance(s).
^(q) stated by CÆSAR.BDD version 2.7 to be false on 11 instance(s) out of 20, and unknown on the remaining 9 instance(s).
^(r) stated by CÆSAR.BDD version 2.7 to be false on 10 instance(s) out of 20, and unknown on the remaining 10 instance(s).
^(s) stated by CÆSAR.BDD version 2.7.
^(t) stated by CÆSAR.BDD version 2.7.
^(u) stated by the CÆSAR compiler.
^(v) stated by CÆSAR.BDD version 2.7.
^(w) stated by CÆSAR.BDD version 2.7.
^(x) stated by the CÆSAR compiler.
^(y) stated by CÆSAR.BDD version 2.7.
^(z) stated by CÆSAR.BDD version 2.7.
^(aa) stated by the CÆSAR compiler.
^(ab) stated by CÆSAR.BDD version 2.7.
^(ac) stated by CÆSAR.BDD version 2.7.
^(ad) stated by the CÆSAR compiler.
^(ae) stated by CÆSAR.BDD version 2.7.
^(af) stated by CÆSAR.BDD version 2.7.
^(ag) stated by the CÆSAR compiler.
^(ah) stated by CÆSAR.BDD version 2.7.
^(ai) stated by CÆSAR.BDD version 2.7.
^(aj) stated by the CÆSAR compiler.
^(ak) stated by CÆSAR.BDD version 2.7.
^(al) stated by CÆSAR.BDD version 2.7.
^(am) stated by the CÆSAR compiler.

(an) stated by [CÆSAR.BDD](#) version 2.7.
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(aq) stated by [CÆSAR.BDD](#) version 2.7.
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(as) stated by the [CÆSAR](#) compiler.
(at) stated by [CÆSAR.BDD](#) version 2.7.
(au) stated by [CÆSAR.BDD](#) version 2.7.
(av) stated by the [CÆSAR](#) compiler.